METHOD FOR EMBEDDING AN AIR DIELECTRIC TRANSMISSION LINE IN A PRINTED WIRING BOARD(PCB).

Claims:

What is claimed is

1. A PCB with internal signal traces on a thin dielectric layer suspended in air between two flat metal plates. Suspension in air is accomplished by indentation of the flat metal plates above and below the trace and a distance away from the edges of the trace, leaving the remainder of the metal away from the indentation to act as a spacer. The indented area is referred to as a "channel". See Figure 1 for orthogonal view and Figure 2 for end-on view.
2. The PCB of claim 1 fabricated by removal of material in the metal plate by etching, milling, punching or shaping or any other method
3. The PCB of claim 1 fabricated by adding material to the metal plate using buy not limited to plating, welding, electro-plating, painting, spraying, or assembly or any other metal build-up process.
4. The PCB of claim 1 fabricated by assembling a combination of metal plates with at least one one plate essentially electrically continuous over the assembly, and at least one metal spacing plate with metal removed from the trace area to keep from shorting the signal. The metal spacing plate(s) may be made by etching, milling punching or any process.
5. The PCB of claim 1 fabricated by shaping of material in the metal plate by but not limited to stamping, drawing or other process. The ridges and valleys of one side can become the valleys and ridges of the opposite side, for the next layer stacked.
6. The PCB of claim 1 fabricated by casting, molding, electro-forming or any similar process to make the metal plate in the desired shape. The ridges

and valleys of one side can become the valleys and ridges of the opposite side, for the next layer stacked.

7. The PCB of claim 1 with dielectric layer strong enough to support the trace between the spacing layers but thin enough to minimize the effect it will have on the composite dielectric constant including the air between the trace and the external conductive planes.
8. The PCB of claim 1 wherein several traces may be used on the same dielectric layer in individual channels.
9. The PCB of claim 1 wherein several traces may be placed within a single channel.
10. The PCB of claim 1 wherein two traces may be placed to operate as a differential pair of signals.
11. The PCB of claim 1 wherein Multiple layers are stacked so that many traces can be routed in the same PCB.
12. single metal plate of claim 1 may have metal indentation on the opposite surface so that the plate serves two different signal traces, one above and one below.
13. The PCB of claim 1 will be 4 or 5 mils thick spacers, conductive layers will be about 1 mil thick, copper trace will be about 1 mils thick and the overall section will be about 12 mils.
14. The PCB of claim 1 wherein channels in the metal plates noted above may be extended to the edges of the PCB or to holes to the surface to provide for air escape or inflow if temperature or altitude changes might cause compression or expansion of trapped air and de-lamination.
15. The PCB of claim 1 wherein attachment of vias for traces of claim 1 may be by (1)removing the dielectric layer with signal trace,(2) drilling a hole larger than the via in the metal plates and spacers, (3)forcing dielectric material into the drill hole in the metal plates individually, (4)laminating the layers together, (5)drilling a smaller via hole through the dielectric material and the pads on the signal trance and (6)plating to connect the via to the signal trace as is normally done.

16. The PCB of claim 1 wherein attachment of vias of claim 1 may be done using several techniques Including the insertion of dielectric spacers or metal pins to electrically connect and to position the connection via.
17. The PCB of claim 1 wherein laminating metal to metal may use an adhesive coating or an adhesive sheet. The adhesive will have no effect on electrical high speed performance because the thin dielectric of the adhesive with wide metal plates forms a high frequency capacitive short from top to bottom plates.

Claims:

What is claimed is

1. A PCB with internal signal traces on a thin dielectric layer suspended in air between two flat metal plates. Suspension in air is accomplished by indentation of the flat metal plates above and below the trace and a distance away from the edges of the trace, leaving the remainder of the metal away from the indentation to act as a spacer. The indented area is referred to as a "channel". See Figure 1 for orthogonal view and Figure 2 for end-on view.
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3. The PCB of claim 1 fabricated by adding material to the metal plate using buy not limited to plating, welding, electro-plating, painting, spraying, or assembly or any other metal build-up process.
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7. The PCB of claim 1 with dielectric layer strong enough to support the trace between the spacing layers but thin enough to minimize the effect it will have on the composite dielectric constant including the air between the trace and the external conductive planes.
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Description:

RELATED APPLICATIONS

The present application claims priority from **U.S. Provisional Application No. 60/391,021** filed on Jun 25, 2002 for Method for making an air dielectric transmission line in a printed wiring board by Ronald Brooks Miller.

US Patent Application no 10/094,761 filed march 11, 2002, Publication no. 2003/0001698 A1 "Transmission structure with an Air Dielectric" describes an air dielectric transmission structure with dielectric cut-outs to provide partial air dielectric.

The notable differences between the cited invention and this invention are:

1. The cited invention is for an assembly made from dielectric spacer layers with cut-out areas for air, while this invention is primarily for metallic spacer layers which can be readily manufactured in standard PCB fabrication process.

2. The cited invention is for a structure, whereas this invention is for a laminated PCB.
3. The cited invention uses arbitrary located cut-outs in the dielectric while this invention uses a channel that follows the signal trace where ever it goes.
4. Wheras the cited invention uses a dielectric spacer, this invention uses dielectric materials plated or otherwise covered with metal to mimic a solid piece of metal in order to shield the trace for improved EMI performance

US Patent Application no 10/015,985 filed Nov 2, 2001, Publication no 2002/0125967 A1, "An Air Dielectric Backplane Interconnection System" describes a backplane with an open transmission line insulated from main backplane using a series of dielectric spacers.

The notable differences between the cited Invention and this invention is that:

1. The cited invention describes an assembly external to a PCB, the backplane, whereas this invention describes a method of embedding the transmission line into the PCB itself.

US Patent Application no 09/751,944 filed on January 2, 2001 by Kim et al, publication no 2001/0015684, "Circuit Board, and method of Manufacturing Therefore" describes a transmission line on the outside of a printed circuit board with supports which hold the line up from the board creating a partial air dielectric for that line and different methods for manufacturing it.

The notable difference between the cited invention and this invention is that whereas the cited invention describes a transmission line on the outside of the printed circuit board this invention is for an internal line with air dielectric. Also, whereas the manufacture of the cited board relies on plating and building up the several layers and then removing them to expose an air transmission line,

this board focuses on the shaping of the metal plates used for shielding and positioning the dielectric carrier which is then assembled or laminated with the dielectric layers which is nearly continuous across the planar surface. The dielectric layer carries the signal traces.

US Patent Application no 09/997,937 filed on December 3, 2001 by David Lee , publication no 2003/0102249 A1, "Method and Apparatus for an Air-Cavity Package." describes a method for encapsulating a PCB with many individually packaged components installed in an air-cavity to form a multi-component assembly.

The cited patent does not address the design or manufacture of the PCB as does the present patent.

US Patent Application no 10-162,277 filed on June 3, 2002 by Noel A. Lopez publication no 2002/0186090 A1, "Method and apparatus for low loss High Radio Frequency Transmission" describes high frequency transmission system using suspended substrate transmission line for coupling several stages of a radio transmission system.

The present patent is not for a radio transmission system but is intended primarily for high speed digital or analog systems.

The cited patent does not address how the design in great detail but leaves implementation undefined. Typically in high frequency equipment suspended substrate is accomplished by sandwiching a piece of circuit board between metal plates and screwing them together.

The present patent is different in that the suspended substrate is embedded in the circuit board.

US Pat nt Application 09/752,059 filed on Dec 29, 2000 by Michael Wright publication no 2002/0084876 A1, "Slotted Ground Plane for Controlling the Impedance of High Speed Signals on a Printed Circuit Board", describes using cut-outs in the ground plane of several shapes in order to raise the impedance of a trace on a particular layer, with no air dielectric used. No claim is made for improved electrical performance other than raising or varying the impedance.

The present patent in contrast uses air as the primary dielectric on these high speed lines, and has several other beneficial performance features.

US Patent Application 09/794,066 filed on Feb 28, 2001 by Albert Pergande publication no 2002/0118083 A1, "Millimeterwave Module Compact Interconnect" describes a method for interconnecting modules using an aperture cut in a ground plane as a coupling medium, for millimeter wavelength applications, and has nothing whatsoever to do with air dielectric printed circuit boards. Whereas the present patent focuses on air dielectric printed circuit boards.

US Patent Application 09/963,641 filed on Sept 27, 2001 by Yuichi Koga publication no 2002/0050870 A1, "Printed Board, Method for Producing the same and Electronic Device having the same, describes a method for equalizing the propagation time of traces with differing lengths in the same printed circuit board by using different dielectric constants and trace widths. The present patent focuses on air dielectric printed circuit boards.

US Patent 6,247,939 B1 issued on June 19, 2001 by Bestul et al, "Connector for making multiple pressed co-axial connections having an air dielectric" describes a method of making an air dielectric connection vertically through a board board laying flat with a pin or in this case with pogo-pins connecting from top to bottom. Since the present patent deals with traces running through the board in a flat dimension with the board laying flat there is no conflict.

US Pat nt 7,712,607 issued on January 27, 1998 by Dittmer, et al, "Air-Dielectric Stripline" describes a method for making a PCB with a partial air dielectric by the inclusion of dielectric spacers laminated into the board. In contrast, the present patent deals with an entire metal layer with the metal removed or absent in some places to provide an air dielectric.

US Patent 5,966,103 issued on October 12, 1999, by Pons et al, "Electromagnetic lens of the printed circuit type with a suspended strip line" describes the making of a lens on suspended substrate.

The important differences between this cited patent and the present patent are:

- Sited patent deals with a lense where the present patent does not.
- and the present patent deals with a suspended line imbedded within a PCB where the cited patent does not.

Patent 4614922 issued on September 20 1986 by Bauman describes a delay line or a microwave transmission line constructed of discrete plates and a PCB to make up a suspended substrate assembly for use in the Radio or RF domain.

The important difference between this patent and the cited patent is:

- Cited patent is made from discrete components whereas this patent is for a PCB assembly.
- Cited patent is for microwave, or RF usage while this patent is for a analog and high-speed digital usage.

US Patent 6,518,844 issued on Feb 11, 2003 by Sherman et al. "Suspended transmission line with embedded amplifier" describes the integration of an assembly of an amplifier or other circuit, with a suspended transmission line assembly.

The cited patent applies to use in the Radio, Microwave and Radar fields. The novelty of this invention is the integration of an amplifier or other discrete circuit into a discretely assembled Suspended Substrate package.

- All Claims of the cited patent are for an amplifier or other discrete assembly integrated into a transmission line assembly for RF applications.
- In contrast, this patent is for a PCB with improved performance high-speed analog and digital performance.

US Patent 6,535,088 issued on March 18, 2003 by Sherman et al. "suspended transmission line and Method"

Is similar to 6,518,844 by Sherman, with the the only difference being that:

- The cited patent does not use an embedded amplifier or assembly,
- The cited patent is different from Patent 4614922 by Bauman only in that
    - the assembly uses a top and bottom trace on the carrier connected together at several points
    - Claim 1 that it is a method for transmitting a signal at a specified frequency.

The figures and most of the detailed text are identical to patent 6,518,844

Accordingly, this patent is different from 6,535,088 in that this one:

- only uses one signal trace as in the origional patent by Bauman above contrasted with the cited patent claim using two traces tied together at several points.
- Is a PCB(not discrete) for the interconnection of digital and analog signals. contrasted with the cited patent claim for transmitting a signal at a specified frequency.

US Patent 6,542,048 issued on April 1, 2003 by Sherman et al. "Suspended Transmission Line with Signal Channeling Device" is similar to 6,518,844 by

Sherman, and differs only in that a signal channeling device (microwave power divider) is implemented in the transmission lines.

- The present patent is different from the patent cited in the same way that it is different from patent 6,535,088.

US Patent 6,552,635 issued on April 22, 2003 by Sherman eta al. "Integrated Broadside Conductor for Suspended Transmission Line and Method" is similar to 6,535,088 and is different only in that no amplifier is embedded in it.

The present patent is different from the patent cited in the same way that it is different from patent 6,535,088.

FIELD OF INVENTION

The present invention relates to a PCB design for application in analog and high speed digital applications using a air-dielectric suspended substrate. This will allow improved signal integrity, lower bit-error-rate, better eye pattern and higher-speed data signals.